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(54) **Method of brazing metal members.**

(57) A brazing method of joining a first metal member at an end portion thereof having a predetermined length to a second metal member formed with a bore having a straight portion and a tapered portion extending from the axially outer end of the straight portion and flaring axially outward. The first member is in a position between a horizontal position and a position inclined at 45 dgrees with a horizontal plane, the position of the first member including the horizontal position but not including the inclined position at 45 degrees. The two members are joined by brazing with the end portion of the first member inserted in the bore straight portion of the second member through the tapered portion and with a brazing material placed around the first member axially outside the tapered portion. When melted for brazing, the brazing material flows axially inward as if it is drawn into the bore tapered portion of the second member around the first member end portion positioned within the tapered portion, and further flows into and is retained in the bore straight portion around the first member end portion positioned in the straight portion, whereby the molten brazing material is prevented from flowing down.

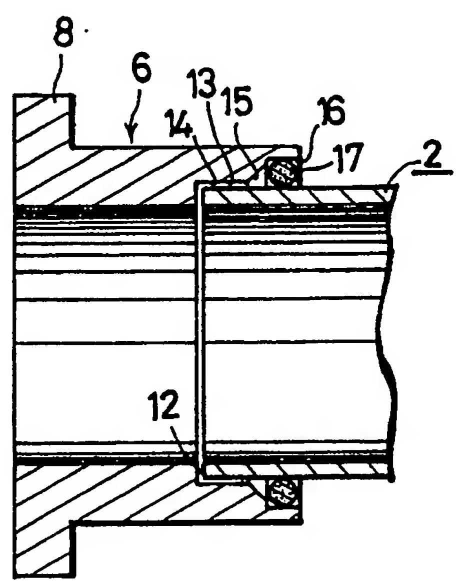

FIG.1

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METHOD OF BRAZING METAL MEMBERS

BACKGROUND OF THE INVENTION

The present invention relates to a method of brazing metal members, and more particularly to a method for use in fabricating motor vehicle intake manifolds, heat exchangers and the like of brazing a first metal member at an end portion thereof having a predetermined length to a second metal member, with the end portion of the first metal member inserted in a bore of the second metal member, the first metal member being in a position between a horizontal position and a position in which the member is inclined at 45 degrees with a horizontal plane, the position of the first metal member including the horizontal position but not including the inclined position at 45 degrees.

The term "aluminum" as used herein and in the claims includes pure aluminum and aluminum alloys. The term "bore" as used herein and in the claims includes both through bore and blind bore. The term "wrought aluminum" as used herein and in the claims refers to an article of aluminum prepared by extrusion, impact extrusion, forging or like plastic working process.

PRIOR ART

For example, a metal pipe 20 having a circular cross section is joined at a horizontal end portion of predetermined length to a tubular metal member 22 having a straight circular bore 21 for receiving the pipe end portion therein by preplaced brazing usually in the manner shown in FIG. 7, i.e., by inserting the end portion of the metal pipe 20 into the bore 21 of the metal member 22, and fitting an annular brazing material 23 of wire around the end portion of the pipe 20 outside the bore 21 but adjacent to the metal member 22.

However, when the brazing material 23 is melted, a portion of the molten brazing material corresponding to the portion of the joint to be formed over a circumferential length including the uppermost part of the joint flows down under gravity, with the result that the molten brazing material encounters difficulty in penetrating into the upper portion of the clearance between the inner peripheral surface of the metal member 22 defining the bore 21 and the outer peripheral surface of the pipe portion inserted in the bore 21 as seen in FIG. 8. Accordingly, the fillet 24 formed at the joint between the metal pipe 20 and the metal member 22 has a diminished upper portion, failing to afford a sufficient joint strength.

SUMMARY OF THE INVENTION

The main object of the present invention is to provide a method of brazing metal members free of the foregoing problem.

The present invention provides a method of brazing a first metal member at an end portion thereof having a predetermined length to a second metal member, with the end portion of the first metal member inserted in a bore of the second metal member, the first metal member being in a position between a horizontal position and a position inclined at an angle of 45 degrees with a horizontal plane, the position of the first metal member including the horizontal position but not including the inclined position at 45 degrees. The method is characterized in that the bore of the second metal member has a straight portion and a tapered portion extending from the axially outer end of the straight portion and flaring axially outward, the two metal members being joined together by brazing with the end portion of the first metal member inserted in the bore straight portion of the second metal member through the tapered portion and with a brazing material placed around the first metal member axially outside the tapered portion.

When the brazing material is melted for brazing according to the method of the invention, the molten brazing material flows axially inward as if it is drawn into the space between the inner peripheral surface of the second member defining the bore tapered portion and the outer peripheral surface part of the first member end portion positioned within the tapered portion, and further flows into and is retained in the clearance between the inner peripheral surface of the second member defining the bore straight portion and the outer peripheral surface part of the first member end portion positioned in the straight portion, whereby the molten brazing material is prevented from flowing down. This precludes the formation of a diminished upper fillet portion at the joint between the two metal members, giving high strength to the joint.

With the above method, the bore of the second metal member preferably has a brazing material placing portion extending from the axially outer end of the tapered portion and not smaller than the largest part of the tapered portion to braze the metal members to each other with the brazing material disposed in the placing portion.

The present invention will be described in

greater detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary view in vertical section illustrating the method of the invention practiced as a first embodiment for brazing a tubular plenum chamber to a throttle body mount to fabricate an intake manifold;

FIG. 2 is a fragmentary enlarged view of FIG. 1;

FIG. 3 is a fragmentary view in vertical section showing the brazed joint formed between the tubular plenum chamber of the intake manifold and the throttle body mount thereof by the method of the present invention;

FIG. 4 is a perspective view of the intake manifold including the tubular plenum chamber and the throttle body mount joined thereto by the brazing method of the invention;

FIG. 5 is a view corresponding to FIG. 2 and illustrating the method of the invention practiced as a second embodiment for brazing a tubular plenum chamber to a throttle body mount to fabricate an intake manifold;

FIG. 6 is a view corresponding to FIG. 2 and illustrating a third embodiment;

FIG. 7 is a fragmentary view in vertical section illustrating a conventional brazing method before a joint is formed; and

FIG. 8 is a sectional view showing two metal members joined together by the conventional brazing method.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the drawings, like parts are designated by like reference numerals and will not be described repeatedly.

FIG. 4 shows a motor vehicle intake manifold fabricated by the method of the present invention. The intake manifold 1 comprises a main pipe 2 of wrought aluminum having a circular cross section and serving as a tubular plenum chamber, and a plurality of branch pipes 5 of wrought aluminum having a circular cross section. The main pipe 2 is open at one end, closed at the other end, has a plurality of holes 3 in its peripheral wall and is integrally formed with branch pipe connecting tubular projections 4 around the respective holes 3. The branch pipes 5 are fitted, each at its one end, to the respective tubular projections 4 and brazed thereto.

A throttle body mount 6 of cast aluminum is brazed to the open end of the main pipe 2. An unillustrated throttle body is attached to the mount 6 and connected to an air supply tube from an air cleaner. The other ends of the branch pipes 5 are collectively brazed to a cylinder head connector 7 of cast aluminum, by which the branch pipes 5 are connected to the cylinder heads of an unillustrated engine. The main pipe 2 and the branch pipes 5 are preferably made of an aluminum material of JIS A6000 series, such as JIS A6063 or JIS A6061.

The throttle body mount 6 is in the form of a hollow cylinder which is open at both ends and is integral with an outward flange 8 at its one end. The main pipe 2 is brazed at its open end to the mount 6 and internally in communication with the interior of the mount. The inside diameter of the mount 6 is approximately equal to that of the main pipe 2. The connector 7 is in the form of a laterally elongated rectangle, has four holes (not shown) and is integrally formed with branch pipe connecting tubular projections around the respective holes. A socket portion 11 for a fuel injector is provided above each projection 10 integrally therewith. The branch pipes 5 are fitted in and brazed to the respective projections 10. Preferably, the throttle body mount 6 and the connector 7 are made of an alloy comprising, for example, 0.50 to 0.65 wt. % of Mg, 0.40 to 0.6 wt. % of Cr, 5.0 to 6.5 wt. % of Zn, 0.15 to 0.25 wt. % of Ti and the balance Al and inevitable impurities.

The intake manifold 1 is fabricated by positioning the main pipe 2 and the connector 7 horizontally to direct the tubular projections 4, 10 vertically upward, and joining the main pipe 2 to the branch pipes 5 and to the throttle body mount 6 and joining the branch pipes 5 to the connector 7 at the same time by brazing. The main pipe 2 is brazed to the mount 6 by the method of the present invention.

For the fabrication of the intake manifold, the main pipe 2 is brazed to the throttle body mount 6 by the method to be described below with reference to FIGS. 1 to 3.

The components prepared are a main pipe 2 made, for example, of wrought aluminum of JIS A6063, and a throttle body mount 6 cast, for example, of an alloy comprising 0.50 wt. % of Mg, 0.50 wt. % of Cr, 5.0 wt. % of Zn, 0.20 wt. % of Ti and the balance Al and inevitable impurities. A step 12 is formed in the inner periphery of the mount 6 at the end portion (on the right-hand side of FIGS. 1 to 3) for the main pipe 2 to be inserted in to provide a large-diameter portion serving as a main pipe socket bore 13. The socket bore 13 has, as arranged from inside axially outward (from left toward right in FIGS. 1 to 3), a straight portion 14 extending from the step 12 and having a diameter slightly larger than the outside diameter of the main

pipe 2, a tapered portion 15 extending from the axially outer end of the straight portion 14 and flaring axially outward, and a brazing material placing portion 16 of circular cross section extending from the axially outer end of the tapered portion 15 and diametrically slightly larger than the largest portion of the tapered portion 15. An annular brazing material 17 circular in cross section and made, for example, of JIS A4343 is placed into the portion 16. The open end of the main pipe 2 is inserted into the straight portion 14 of the socket bore 13 in the mount 6 through the placing portion 16 and the tapered portion 15. The clearance between the outer surface of the main pipe 2 and the inner surface of the mount 6 defining the straight portion 14 is preferably about 0.1 mm. The clearance between the outer surface of the main pipe 2 and the mount inner surface defining the placing portion 16 is preferably about 2 mm. The axial length of the tapered portion 15 is preferably about 2 mm.

At the same time, one end of each branch pipe is inserted into the tubular projection 4, and the other end thereof into the tubular projection 10 of the connector 7, and a brazing material is provided between the main pipe projection 4 and the branch pipe 5 and between the connector projection 10 and the branch pipe 5. The assembly of main pipe 2, branch pipes 5, mount 6 and connector 7 is then placed into a furnace, with the main pipe 2 positioned horizontally in its entirety to direct the tubular projections 4, 10 vertically upward, and heated in a nitrogen gas atmosphere or in a vacuum within the furnace, for example, at 605°C for 3 minutes with use of a chlorine flux to thereby collectively join the main pipe projections 4 to the respective branch pipes 5, the main pipe 2 to the mount 6 and the branch pipes 5 to the respective connector projections 10 by brazing.

During the brazing operation, the brazing material provided in the placing portion 10 of the bore 13 in the mount 6 melts, and the molten brazing material flows axially inward as if it is drawn into the tapered portion 15 of the mount bore 13 around the main pipe portion positioned within the tapered portion 15, and further flows into and is retained in the straight portion 14 of the mount bore 13 around the main pipe portion positioned within the straight portion 14, whereby the molten brazing material is prevented from flowing down. As shown in FIG. 3, therefore, a fillet 18 which is uniformly sized over the entire circumference without any break is formed in the straight portion 14 and the tapered portion 15 of the mount bore 13 around the main portion present in these portions 14, 15, hence a satisfactory joint. The fillet 18 is formed also between the end face of the main pipe 2 and the step 12 substantially uniformly over the entire circumference.

FIG. 5 shows a second embodiment of the present invention, in which a brazing material placing portion 16 has a slightly larger axial length than in the first embodiment. The diameter of the portion 16 at its axially inner end is equal to that of the axially outer end of a tapered portion 15. An annular brazing member 1 provided in the placing portion 16 has an axially elongated rectangular cross section and partly projecting outward from the portion 16.

FIG. 6 shows a third embodiment of the invention, in which a socket bore 13 has no brazing material placing portion 16. An annular brazing material 17 of circular cross section is provided around a main pipe 2 outside the socket bore 13.

Although the annular brazing materials of the foregoing embodiments are circular or rectangular in cross section, the material is not limited to such a form. The method of the invention is employed for brazing the main pipe of wrought aluminum serving as the plenum chamber of an intake manifold for motor vehicles to the throttle body mount of cast aluminum thereof according to the foregoing three embodiments, whereas the method is not limited to this application. The present method can be used also for brazing components of other articles such as heat exchangers.

Claims

1. A method of brazing a first metal member at an end portion thereof having a predetermined length to a second metal member, with the end portion of the first metal member inserted in a bore of the second metal member, the first metal member being in a position between a horizontal position and a position inclined at an angle of 45 degrees with a horizontal plane, the position of the first metal member including the horizontal position but not including the inclined position at 45 degrees, the method being characterized in that the bore of the second metal member has a straight portion and a tapered portion extending from the axially outer end of the straight portion and flaring axially outward, the two metal members being joined together by brazing with the end portion of the first metal member inserted in the bore straight portion of the second metal member through the tapered portion and with a brazing material placed around the first metal member axially outside the tapered portion.

2. A method as defined in claim 1 wherein the bore of the second metal member has a brazing material placing portion extending from the axially outer end of the tapered portion and not smaller than the largest part of the tapered portion, and the brazing material is disposed in the placing portion.

3. A method as defined in claim 1 or 2 wherein the first metal member and the second metal member are made of aluminum.

4. A method as defined in claim 1 or 2 wherein the first metal member is a tubular plenum chamber made of wrought aluminum for an intake manifold, opened at the end portion and closed at the other end, and the second metal member is a tubular throttle body mount of cast aluminum for the intake manifold.

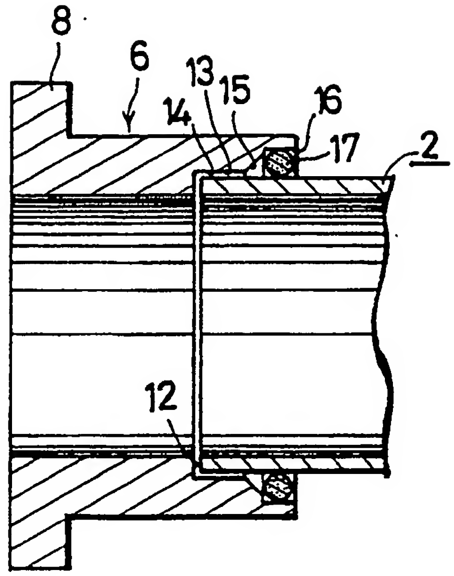


FIG.1

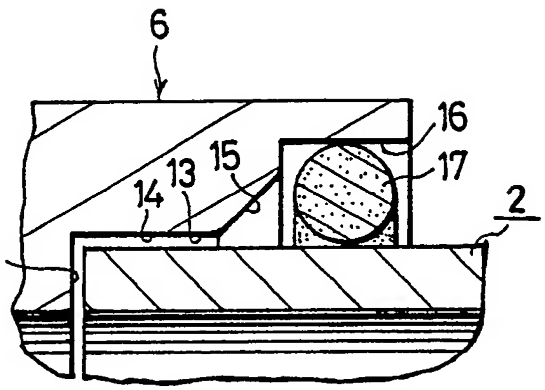


FIG.2

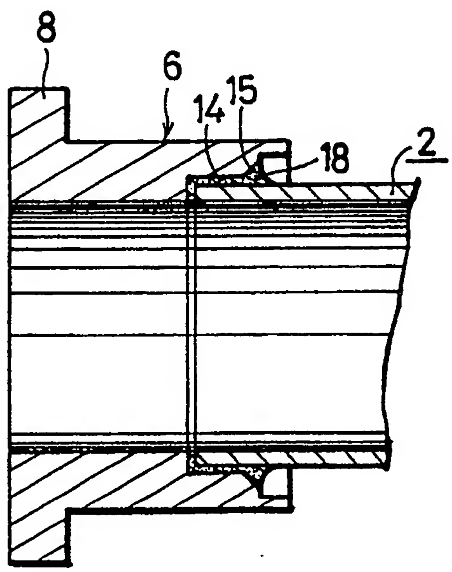


FIG.3

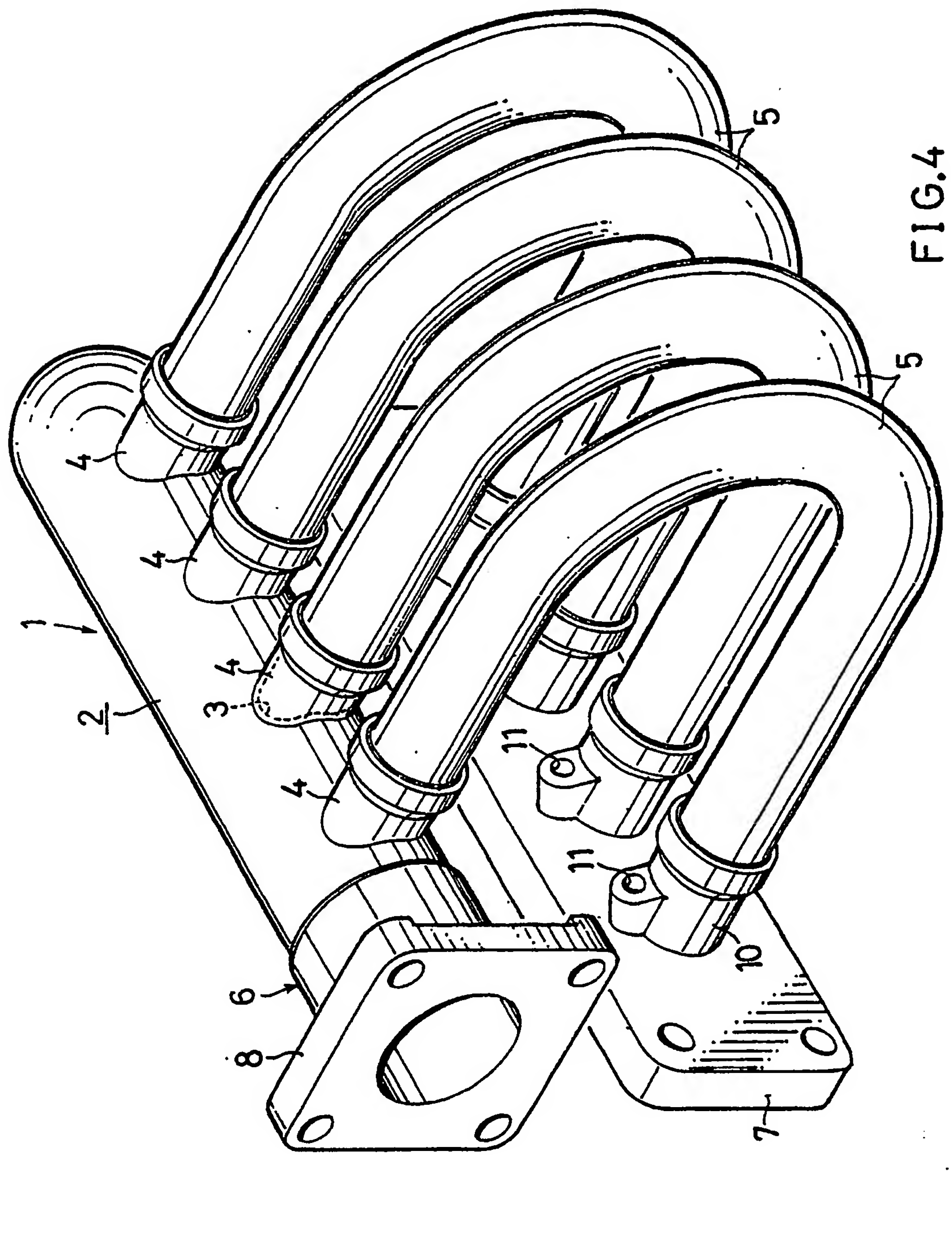


FIG.4

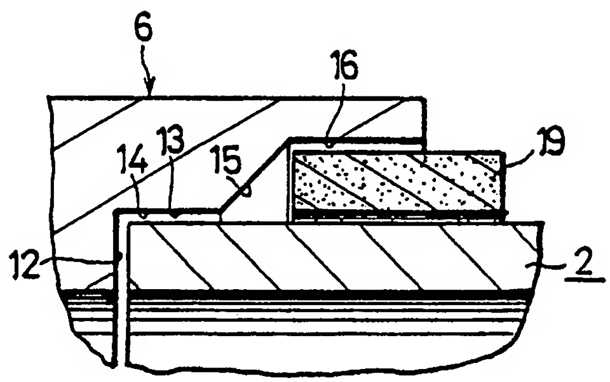


FIG.5

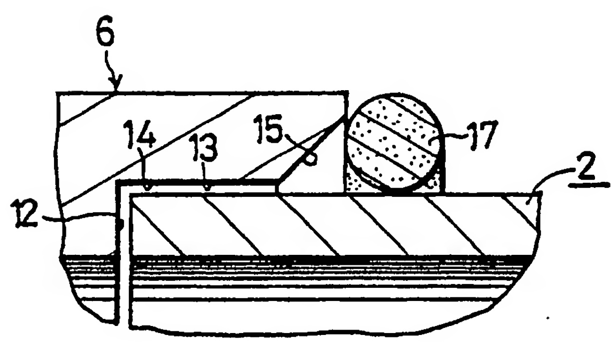
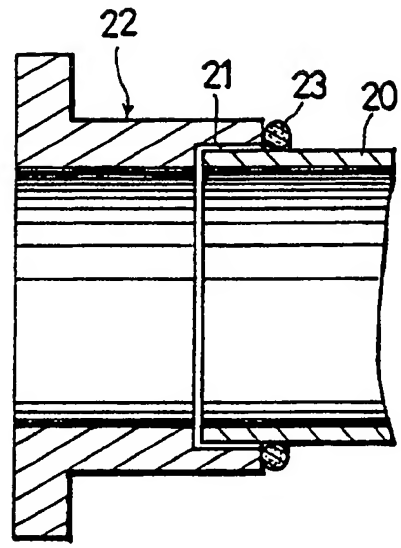
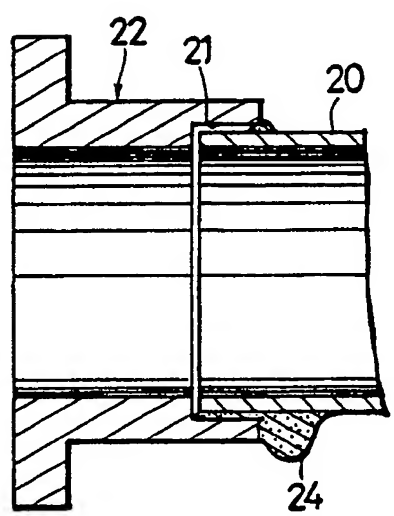


FIG.6



PRIOR ART

FIG.7



PRIOR ART

FIG.8